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A new locality of *Solidago ×niederederi* Khek (Asteraceae) in Poland

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Abstract: *Solidago ×niederederi* is a natural hybrid between *S. canadensis* and *S. virgaurea*, which occurs sporadically in synanthropic habitats together with the parental species. The hybrid was reported from seven countries in Central and Northern Europe and its presence emphasizes the invasive character of *S. canadensis*. A new locality of the hybrid was found in Mieruniszki village in the Zachodniosuwalskie Lakeland in NE Poland in 2011 (ATPOL square: FB06). *Solidago ×niederederi* grew on fallow land, at the edge of planted birchen shrubbery and its population comprised two small clumps. Current data suggest that the hybrid is a casual alien in the Polish flora, however, it has the potential to become established by clonal growth or restricted sexual reproduction.

Key words: *Solidago ×niederederi*, plant hybridisation, invasive species, casual alien, Poland

1. Introduction

Natural hybridisation between introduced plant species and closely related native taxa is one of the major indirect effects of biological invasions (Vilà *et al*. 2000). Some of such hybrids can intensively grow and rapidly spread, replacing indigenous species by competition (Daehler & Carino 2001). Hybridisation involving native and alien plants was confirmed in the case of *Solidago ×niederederi* Khek (Asteraceae family), an interspecific hybrid between *S. canadensis* L. and *S. virgaurea* L. The parental species of the hybrid have different geographical distributions. *Solidago virgaurea* is native to Europe, northern Africa and western Asia in the Caucasus and western Siberia (Wagenitz 1979). *Solidago canadensis* is native to North America and occurs widely throughout the USA and Canada (Semple & Cook 2006). In the 17th century *S. canadensis* was introduced to Europe as an ornamental plant (Kowarik 2003). Within the 19th century it became an established anthropophyte, spreading rapidly in synanthropic habitats in many European countries (Weber 1998), and is currently considered as invasive (Kabuce & Priede 2010). In Poland, naturalisation of *S. canadensis* began from the second half of the 19th century (Tokarska-Guzik 2005). Nowadays, the species is a very common invasive plant, which still enlarges its range (Szymura & Wolski 2006; Nowak & Kącki 2009; Tokarska-Guzik *et al*. 2012).

The hybrid between *S. canadensis* and *S. virgaurea* was discovered at the beginning of the 20th century in Austria (Khek 1905), more than 60 years after the first record of *S. canadensis* in this country (Weber 1998). The first hybrid locality in Poland was found in 1957 in the town of Drohiczyn at the Bug River (Rostański 1971). During the floristic investigation carried out in the Zachodniosuwalskie Lakeland (NE Poland) in 2011, a new locality of *S. ×niederederi* was found.

2. Materials and methods

Solidago ×niederederi was described by Eugen Khek, who named it after its discoverer, Niedereder (Khek 1905). In English, the species is called Niedereder's goldenrod, and in Polish, nawłoć Niederedera. The hybrid description was extended by Nilsson (1976), who found the plant in Sweden and Denmark. The parental species belong to different taxonomical sections, however, hybridisation in the genus *Solidago* is relatively common, even among species of different sections. *Solidago canadensis*, which belongs to the section *Unilaterales* subsection *Triplinerviae*, has elongate

Fig. 1. Herbarium specimen of *Solidago ×niederederi* Khek from the newly discovered locality in Poland (*leg*. Artur Pliszko, deposited in KRA)

rhizomes, three-nerved leaves, capitula densely arranged in a pyramidal panicle. In contrast, *S. virgaurea*, a member of the section *Solidago* subsection *Solidago*, has short rhizomes, net-veined leaves, capitula in a cylindrical to ellipsoidal thyrse (Nesom 1993). Both species are outcrossing, insect-pollinated perennials with protandrous flowers (self-incompatibility). They spread by anemochorous fruits (Werner *et al*. 1980; Melville & Morton 1982) and are diploids possessing the same chromosome number (2n=18) (Melville & Morton 1982; Rutkowski 2004). The hybrid is morphologically intermediate (Table 1) and produces only very few well-developed achenes (Nilsson 1976). Considering inflorescence and leaf shapes, some specimens are closer to *S. virgaurea* (Leute 1986).

Solidago canadensis and *S. virgaurea* are highly variable and their taxonomy requires critical revision (Nesom 1993; Weber 1997). Identification of the hybridogenous specimens of *Solidago* can be very difficult. It could be possible that other introduced species from the *S. canadensis* complex hybridise with *S. virgaurea* in Europe, especially *S. altissima* L. (= *S. canadensis* var. *scabra* Torr. et A. Gray), which is morphologically very similar to *S. canadensis* and may have the same number of chromosomes (Weber 1997). Moreover, some artificial hybrids, e.g., the cultivar *S. ×arendsii* f. *Ballardii* Bergm. from Danish gardens, resemble *S. ×niederederi* in morphology and fertility (Nilsson 1976).

Solidago ×niederederi has been reported from seven countries in Europe: Austria (Khek 1905; Melzer 1984, 1985, 1987; Leute 1986, 2003; Polatschek 1997, 2001), Poland (Rostański 1971), Denmark and Sweden (Nilsson 1976), Norway (Sunding 1989), United Kingdom (Burton 1980; Stace 1999) and Germany (Bleeker *et al*. 2007; Junghans 2011). Most records came from Austria (Styria, Carinthia, Tyrol). The hybrid is mainly reported from the central and northern part of the continent, within the range of its parental species. In spite of the common occurrence of the parental species (Lambdon

Table 1. Selected morphological features distinguishing *Solidago canadensis*, *S. virgaurea* and *S. ×niederederi* (after Semple & Coock 2006; Nilsson 1976; Burton 1980; modified with own observations)

S. canadensis L. s. str.	*S. virgaurea* L. s. str.	*S. ×niederederi* Khek
stems numerous in cluster, pubescent at the upper half, greenish-tinged, erect, about 1.5-2.0 m tall	stems not numerous, almost glabrous, purplish-tinged, erect to slanting, about 0.5-1.0 m tall, but often much less	stems usually numerous in cluster, pubescent at the upper half, greenish-tinged or faintly purplish, erect to slanting, about 1.2-1.5 m tall
leaves lanceolate, with 1 pair of main lateral veins from near base, running parallel with midrib for most of length, numerous on the stem, the basal leaves not persistent	leaves oblanceolate, obovate to spatulate, strongly narrow at petiolar-like region, with many pairs of short lateral veins, not numerous on the stem, the basal usually persistent	leaves lanceolate, oblong cuneate near base with a very fine reticulation, numerous on the stem, the basal not persistent
branches with capitula forming a conelike panicle (lower branches diverge at a wide angle and recurved outwards, pubescent), involucre 1.7-2.5 mm high	branches with capitula forming a cylindrical panicle (branches usually short and ascending, diverge at an acute angle, almost glabrous), involucre 5-6 mm high	branches with capitula forming a conelike panicle (branches short and ascending, diverge at an acute angle, pubescent), involucre 3-4 mm high

et al. 2008; Seregin 2011) and the invasive character of *S. canadensis* in many European countries (Kabuce & Priede 2010), the hybrid is reported rarely, but this could be the result of being overlooked. *Solidago ×niederederi* occurs primarily in disturbed habitats such as ruderal grounds, clay pits, abandoned gravel pits, limestone quarries, railway embankments (Nilsson 1976; Burton 1980), urban and suburban areas (Leute 1986, 2003) and river embankments (Melzer 1984). The hybrid usually grows together with one or both parental species and its populations are not numerous (Nilsson 1976; Melzer 1984; Leute 1986).

The identification of the newly collected specimens of the hybrid from Poland was based on a supplemental description and on drawings presented by Nilsson (1976). Specimens of conjectural parents collected with the hybrid were identified in conformity with the description given by Semple & Cook (2006) and the key by Rutkowski (2004). Specimens of *Solidago ×niederederi* have been deposited in the Herbarium of the Institute of Botany of the Jagiellonian University in Cracow (KRA) (Fig. 1). Phytosociological relevé was made using the standard Braun-Blanquet method. The names of vascular plant species follow Mirek *et al*. (2002). The names of syntaxonomical classes and their diagnostic species are given after Mucina (1997). Additionally, a new record of *S. ×niederederi* in Poland is presented on the map according to the ATPOL cartogram grid (Zając 1978).

3. New locality of the hybrid in Poland

Solidago ×niederederi was found in Mieruniszki village in the Zachodniosuwalskie Lakeland in 2011. The new finding, which represents the second record from Poland, is situated in the FB06 square of the ATPOL cartogram grid (Fig. 2), where capital letters indicate the 100-km square and the numbers indicate the 10-km square. Both Polish localities of the hybrid are located in the Podlaskie Voivodeship. *Solidago ×niederederi* is probably more frequent since its parental species have numerous localities in Poland (Zając & Zając 2001).

In Mieruniszki village, the hybrid occurs on fallow land, at the edge of shrubbery of planted *Betula pendula* Roth (Fig. 3). It grows among its parental species in mesic sandy clay soil in semi-shade condition. The following phytosociological relevé shows the synanthropic character of the habitat:

Location: Mieruniszki village (54°10`43`` N, 22°32`04`` E), *ca*. 300 m W of the shore of lake Mieruńskie Wielkie, date: 17.08.2011, area of relevé 25 m², cover of cultivated plants (*Betula pendula*) B: 50%, cover of herb layer C: 80%, no. of species: 30.

Ch. *Artemisietea vulgaris*: *Anthemis tinctoria* +, *Artemisia vulgaris* 2, *Calamagrostis epigejos* 1, *Elymus repens* 1, *Equisetum arvense* +, *Erigeron annuus* s. str. 1, *Oenothera biennis* s. str. +, *Picris hieracioides* s. str. +; **Ch. *Galio-Urticetea***: *Carduus crispus* +, *Geum urbanum* +, *Solidago canadensis* 1, *Urtica dioica* s. str. +; **Ch. *Epilobietea angustifolii***: *Calamagrostis epigejos* 1, *Fragaria vesca* +, *Rubus idaeus* 1; **Ch. *Molinio-Arrhenatheretea***: *Achillea millefolium* s. str. 1, *Anthriscus sylvestris* 1, *Campanula patula* +, *Dactylis glomerata* s. str. 2, *Knautia arvensis* +, *Phleum pratense* +, *Poa pratensis* s. str. + , *Vicia cracca* +; Others: *Agrostis gigantea* 1, *Betula pendula* 3 (B), *Epilobium*

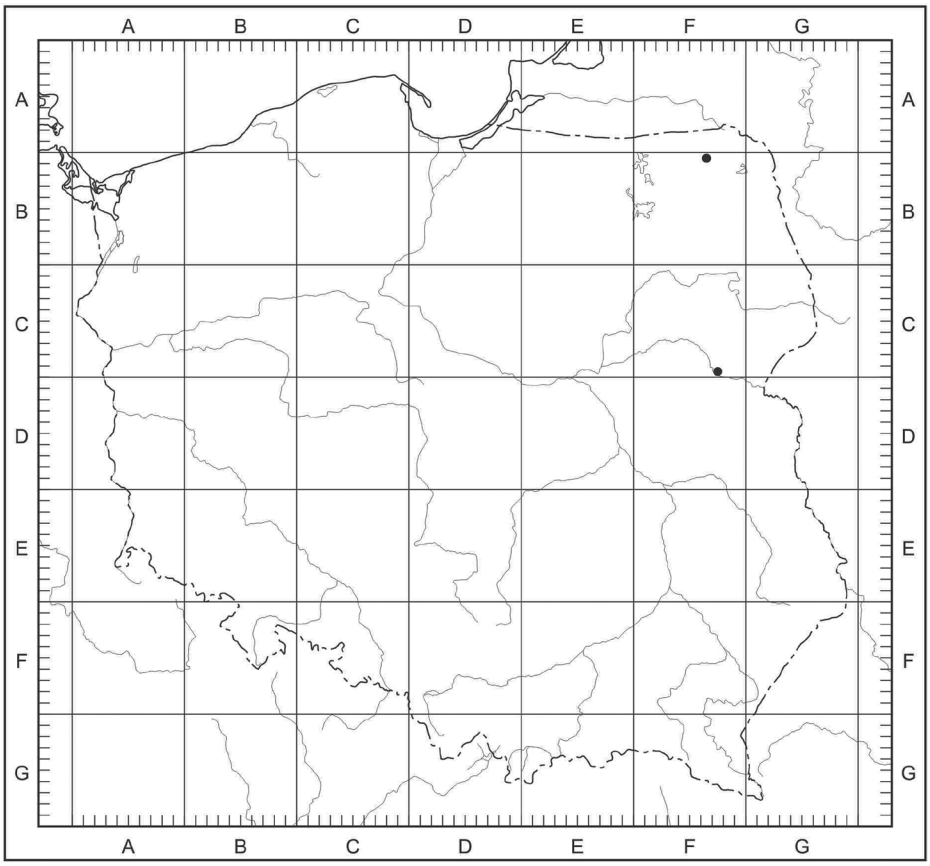

Fig. 2. Distribution of *Solidago ×niederederi* Khek in Poland (according to the ATPOL grid: FC97 – Drohiczyn town, *leg.* M. Ambrożewska 1957; FB06 – Mieruniszki village, *leg*. A. Pliszko 2011)

montanum +, *Hieracium umbellatum* 1, *Lupinus polyphyllus* 1, *Melandrium album* +, ***Solidago ×niederederi*** **1**, *Solidago virgaurea* 2.

The population of *S. ×niederederi* consists of two small clumps (one with 6 stems and the other with 21 stems), which are probably two clones. Individual

Fig. 3. Flowering *Solidago × niederederi* Khek in Mieruniszki village in NE Poland (photograph by Artur Pliszko, 17.08.2011)

clones of *Solidago* can easily be recognized in the field by their clumps of stems. During the field survey, capitula of the hybrid were visited by flies (*Musca* sp.).

4. Status of the hybrid in the Polish flora

According to Pyšek *et al*. (2004), hybrids between alien and native plants should be treated as alien taxa. Consequently, *Solidago ×niederederi* is an alien species, but its persistence is uncertain. In the light of the current data, the hybrid is not established in the Polish flora, but belongs to casual aliens or diaphytes (ephemerophytes). According to the geographical-and-historical classification of plants by Kornaś (1977), *S. ×niederederi* is a synanthropic hybrid between a kenophyte (*S. canadensis*) and an apophyte (*S. virgaurea*).

For Denmark and Sweden, Nilsson (1976) considers the spontaneous *S. ×niederederi* as naturalised. This assumption is contradictory to the fact, that the sexual reproduction of the hybrid is restricted, because independent and constant ability to form self-replacing populations is necessary to confirm the establishment of alien plants (Pyšek *et al.* 2004). It is currently difficult to disagree with a casual character of *S. ×niederederi* in the flora of Europe, however, the hybrid has the potential to be naturalised by vegetative propagation. It may have a strong regeneration ability from rhizome fragments inherited from its parent, *S. canadensis* (Weber 2011). Introgression has not been confirmed in the case of *S. ×niederederi*, and there is a need for further research on the persistence of the hybrid.

5. Conclusions

In Poland, the invasive alien *Solidago canadensis* spontaneously hybridises with native *S. virgaurea*. The hybrid *Solidago ×niederederi* is known from two localities, but its rareness probably is a consequence of poor recognition during the field studies. It usually has the intermediate morphological characteristics. The hybrid inhabits areas disturbed by human activities, where the parental species occur together. *Solidago ×niederederi* is a casual alien (ephemerophyte) in the Polish flora, but its status may change in the future.

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